

## CONTENTS

Program Overview .....	1
Site Map.....	2
Questions and Answers .....	3
Ground Water .....	5
Surface Water (Streambed Sediment).....	6
Biosolids .....	7
Soils .....	8
Crops .....	8
Data .....	9
Definitions .....	12
Contacts.....	12

## Program Overview

Metro Wastewater Reclamation District (Metro District) applies biosolids to their properties near Deer Trail, Colorado. These biosolids applications could affect the quality of water in alluvial and bedrock aquifers, streambed sediments, soils, and crops.

Water quality can be directly affected through:

- Contaminated recharge water, or
- Infiltration of water through contaminated soils or sediments (remobilization).

*Continued on page 3*

## USGS

*The U.S. Geological Survey is a science organization that provides the Nation with reliable, impartial information to describe and understand the Earth. The national USGS home page: <http://www.usgs.gov>*

## This USGS program:

The Internet address for this program, including links for data and reports, is:

<http://co.water.usgs.gov/projects/CO406/CO406.html>

The Internet address for just the data is:

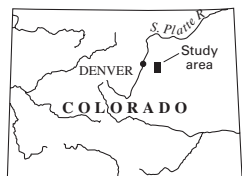
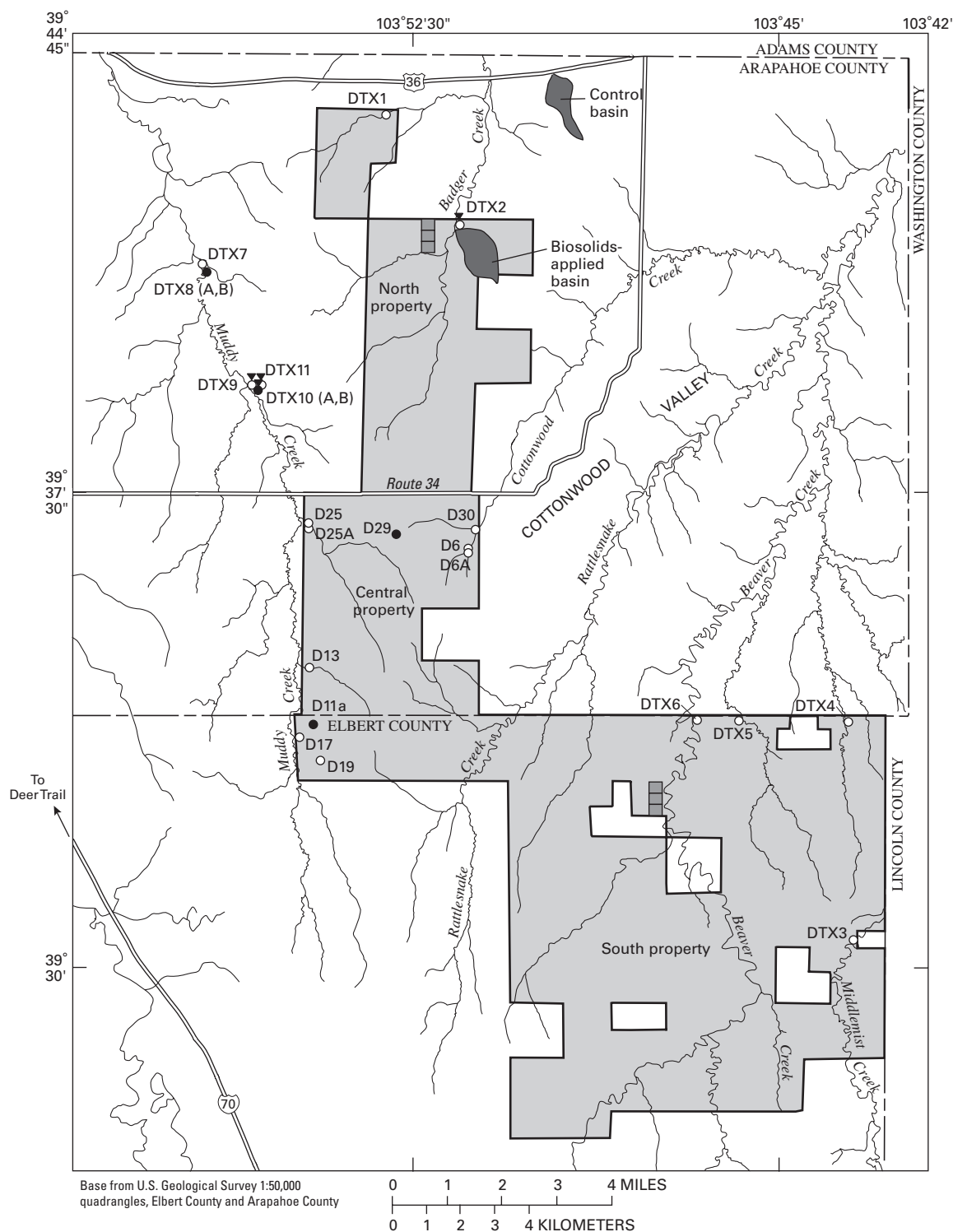
<http://co.water.usgs.gov/projects/CO406/data.html>

or <http://water.usgs.gov/co/nwis>



**The USGS collected some unusual samples this spring as part of the new USGS monitoring program near Deer Trail.**

**Possible source materials (including cow manure and biosolids) were sampled for isotope analysis to evaluate the source of the nitrate in well D6.**



## EXPLANATION

- Metro Wastewater Reclamation District property
- DTX1○ USGS alluvial-aquifer monitoring well and identifier (table 11)
- D29● USGS bedrock-aquifer monitoring well and identifier (table 11)
- DTX2⦿ Monitoring well with continuous recorder and identifier (table 11)
- Streambed-sediment sampling area
- Soil-sampling area

**Location of study area and U.S. Geological Survey monitoring sites near Deer Trail, Colorado, 2005–2010. (Metro Wastewater Reclamation District property boundaries shown are from 1999.)**

## Program Overview

*Continued from page 1*

Water quality can be indirectly affected through:

- Tilling that mobilizes or changes subsurface chemical constituents, or
- Contributions to natural processes such as nitrification.

Contaminated ground water or surface water could contaminate:

- Other aquifers, such as bedrock water-supply aquifers or alluvial aquifers,
- Other surface-water bodies (ponds or streams), or
- Streambed sediments.

Biosolids must meet metals and radioactivity regulations, or else agro-nomic loading rates will be incorrect and soils could be overloaded. Soil quality could either be improved by biosolids applications through increased nutrients and organic matter, or degraded through excessive nutrients or metals.

The U.S. Geological Survey (USGS) has a monitoring program to address concerns from a stakeholder

group about the biosolids and the quality of the environment in the vicinity of the biosolids-application areas. The USGS monitoring program near Deer Trail is referred to as the “USGS Expanded Monitoring Program” and began in January 1999. The first phase of monitoring ended in 2003. All data and interpretive reports from the 1999–2003 monitoring period were published by January 2005 and are available to the public. An interim monitoring period (2004 through mid-2005) continued the monitoring while reports were completed, results were presented, and a new phase of the monitoring program was negotiated for 2005–2011.

Each USGS monitoring program builds on the previous monitoring program. Results from the previous monitoring program are used to determine priorities for the next phase of study. The USGS Expanded Monitoring Program is distinct from, but builds on, another USGS program that monitored shallow ground-water quality on the Metro District Central Farm from 1993–98. The newer program (1999–2011) considers environmental-quality issues for shallow and deep ground water, surface water (streambed sediments), biosolids, soils, and crops. The new expanded monitoring program in-

cludes all three Metro District properties (North, Central, and South Farms) and related private-property locations. Both programs, however, use USGS and Metro District funds. In addition, the newer monitoring program also used funds from the North Kiowa Bijou Groundwater Management District. Both programs are designed, carried out, and interpreted independently by USGS, and quality-assured USGS data and reports will be released to the public and the Metro District at the same time. By definition and design, all USGS monitoring programs are independent and unbiased.

The objectives of the USGS Expanded Monitoring Program are to:

1. Evaluate the combined effects of biosolids applications, land use, and natural processes on alluvial aquifers, the bedrock aquifer, streambed sediments, soils, and crops by comparing chemical data to
  - State or Federal regulatory limits,
  - Data from a site where biosolids are not applied (a control site), or
  - Earlier data from the same site (trends).
2. Monitor biosolids for chemistry, and compare the concentrations with regulatory limits.

*Continued on page 4*

## Questions & Answers

Q: What is the status of USGS reports for the study area near Deer Trail?

A: Four data reports are published and available. An interpretive report about the effects of biosolids on soil, crops, ground water, and streambed sediment (1999–2003) is published and available. Also published and available is an interpretive hydrogeology report that includes the structure maps done as part of the bedrock ground-water monitoring component. Visit the web-site (see page 1) or contact Tracy Yager at the USGS to obtain copies. The interpretive water-quality report for 1993–99 has been written and is in preparation for further review.

Q: Is the USGS still monitoring near Deer Trail?

A: Yes, the USGS began a new phase of the monitoring program in May 2005 in cooperation with the Metro District. Monitoring is scheduled for 2005 through 2010. Reports will be prepared in 2011.

Q: Will the USGS monitor the same sites during this phase (2005–2010) as during the previous phases (1999–2005)?

A: For biosolids, soil, crops, and streambed sediment, the USGS will monitor the same sites as during the previous phases (1999–2005). For ground water, monitoring of some sites will be less frequent or discontinued during this phase (2005–2010) based on susceptibility to contamination from biosolids indicated from the previous phase (1999–2003). However, five of the ground-water sites will continue to be sampled quarterly.

## **Program Overview**

*Continued from page 3*

3. Determine the aquifer hydrology in this area.

The approach is unique for each component of the monitoring program. However, appropriate USGS methods and technologies will be applied to each component.

Progress reports such as this one were prepared quarterly for the first 2.5 years of the program and now are prepared once each year and distributed to the stakeholders and other concerned people, as well as available to the general public on the Internet (<http://co.water.usgs.gov>). Each progress report summarizes progress from the previous period and plans for the current period; chemical data are included when available. USGS reports will document all methods and data for the monitoring program. A comprehensive USGS report will be prepared and available after 2010 that includes complete statistical analyses and interpretations. In addition, the USGS will meet with the stakeholders once a year to discuss the USGS Expanded Monitoring Program results and to consider possible changes to the Expanded Monitoring Program.

## **Progress Last Period** **(July 2004–June 2005)**

Four reports were completed, published, and distributed. Results for the 1999-2003 monitoring period were presented to the stakeholders (10/12/04), biosolids producers (4/18/05), USGS (4/20/05), Pikes Peak Area Council of Governments (4/26/05), USGS water laboratory (6/9/05), and Metro District laboratory (6/22/05). The USGS met with small groups of

stakeholders to discuss the previous and next phase of the monitoring program on 7/27/04, 11/29/04, 12/1/04, 12/15/04, 12/16/04, and 2/15/05. The USGS met with all interested stakeholders together on 1/27/05. The proposals for the new phase of the monitoring program (2005-2011) were written, reviewed, revised, and finally approved by the necessary parties in April 2005. Work began on the new phase of the monitoring program in May 2005. The stakeholder mailing list was reviewed and updated. The USGS also participated in multi-agency discussions about organic wastewater compounds (emerging contaminants) during this period.

## **Plans for the Current Period** **(July 2005–June 2006)**

The annual stakeholder meeting was September 28, 2005, at the Metro District shop near Deer Trail, Colorado. The USGS provided updates on progress and findings at this meeting. The USGS continues to participate in multi-agency discussions about organic wastewater compounds (emerging contaminants) and will provide a poster about biosolids for the South Platte Forum/CREEC workshop on emerging contaminants October 27, 2005. The USGS has been asked to give a presen-

*Continued on page 5*



***Quarterly ground-water sampling continued after the previous phase of the monitoring program ended in September 2003. As part of sampling the ground water, field parameters such as alkalinity are measured.***

## Program Overview

*Continued from page 4*

tation about organic wastewater compounds (emerging contaminants) in biosolids at a conference in Aurora on November 17, 2005. The USGS is working on a proposal to add an air-quality monitoring component to the monitoring program; field work for the air-quality component is proposed to begin in spring 2006. The interpretive water-quality report for 1993–99 will be revised and further reviewed.

## Ground Water

### Approach

Five USGS monitoring wells installed near the Metro District property boundaries in some of the major alluvial aquifers are sampled approximately quarterly for full inorganic chemistry. These wells also were sampled in 2005 for organic wastewater compounds. One of these wells (D6) and three up-



***A nitrogen-source study is part of the new phase of the monitoring program and includes shallow soil coring at five locations in the study area in 2005. Each of the five locations was selected to represent a nitrogen-source scenario, such as biosolids on farmland (above) or farmland without grazing or biosolids.***



***Field-aged biosolids (dark area of photograph near scale) were sampled by the USGS in spring 2005 for both nitrogen-isotope analysis and organic wastewater analysis. Soil at the field-aged biosolids location also was sampled to a depth of about 5 feet using a stainless-steel auger.***



***In June 2005, ground-water samples were collected from selected wells for dissolved-gas and nitrate-isotope analyses. The bottles for dissolved-gas analysis are filled under water (inside the bucket) to prevent contamination of the sample by atmospheric gases.***

gradient wells were sampled in 2005 for nitrate isotopes. Possible nitrogen source materials such as biosolids, soil, and rock, also were analyzed in 2005 for nitrogen isotopes. Additional USGS monitoring wells in the study area also will be sampled each year when streambed-sediment samples are not

available. Two USGS monitoring wells installed downgradient from the Metro District property in the bedrock aquifer are sampled annually for full inorganic chemistry. Depth to water is measured approximately monthly at about 20 of the USGS monitoring wells. At two

*Continued on page 6*

## **Ground Water**

*Continued from page 5*

sites, depth to ground water, precipitation, and other related parameters are recorded hourly. Chemical data will be reviewed and statistically tested for exceedance of regulatory limits and for trends. Data also will be evaluated for a possible biosolids signature and for ground-water hydrology.

### **Progress Last Period** **(July 2004–June 2005)**

Depth to ground water was measured July, August, September, October, and December 2004, and January, February, April, May, and June 2005.

Ground water was sampled for chemistry July, October, January, May, and June. Ground water at selected sites was sampled for nitrate isotopes May 31–June 1, 2005. Ground-water data were compiled and reviewed. Two continuous-recorder instrumentation sites were dismantled, and the remaining instrumentation was calibrated.

### **Plans for the Current** **Period** **(July 2005–June 2006)**

Ground water at selected sites was sampled for organic wastewater compounds in July 2005. Depth to ground water will be measured approximately monthly. Ground water at selected sites will be sampled quarterly. Data will be compiled and reviewed.

## **Surface Water** ***(Streambed Sediment)***

### **Approach**

Surface-water contamination is a concern for the stakeholders, but streams flow off the Metro District properties only during runoff when surface-water sampling is impractical. Therefore, possible surface-water contamination from metals is evaluated by sampling streambed sediments soon after storms. Two small drainage basins were selected for similar characteristics but different land use—one drainage basin in a biosolids-application field and another drainage basin in a farmed field (not on the Metro District properties) that does not receive biosolids. A downstream part of each of the two drainage basins will be

*Continued on page 7*



***Crop sampling and analyses will be included in the new phase of the USGS Expanded Monitoring Program near Deer Trail, 2005–2011.***



## **Surface Water (Streambed Sediment)**

*Continued from page 6*

sampled after the same storms once each year (if samples can be collected) for inorganic constituents (including metals, total nitrogen, and total phosphorous) and organic carbon. Data will be reviewed and statistically tested to determine if concentrations are significantly different between the two drainage basins.

## **Progress Last Period (July 2004–June 2005)**

The site was carefully monitored for runoff-producing rainfall. Runoff was not sufficient to enable streambed-sediment sampling during this period.

## **Plans for the Current Period (July 2005–June 2006)**

The site will be monitored for runoff-producing rainfall. Sampling may take place, depending on the weather.



***Two continuous-recorder instrumentation sites will be operated during the new phase (2005–2010) of the monitoring program. The sites that will be continued are the DTX2 site and the DTX9/DTX10/DTX11 site. The DTX2 continuous-recorder data are still available on the Internet. Continuous-recorder data for precipitation and air temperature at D25 also are temporarily available on the Internet.***

## **Biosolids**

### **Approach**

Biosolids samples are collected as a 24-hour composite from the Metro District plant and analyzed for trace elements through the USGS. Biosolids are sampled and analyzed at least once each quarter. Data will be reviewed and compared to Federal regulatory limits. Selected biosolids samples were analyzed for organic wastewater compounds (emerging contaminants). Selected biosolids samples were leached with pure water in 2005; the leachates were analyzed for organic wastewater compounds (emerging contaminants).

## **Progress Last Period (July 2004–June 2005)**

Biosolids samples were collected each month. Each sample was a 24-hour composite from the conveyor belt at the Metro District facility. The material was placed in acid-washed, one-gallon plastic or glass bottles and transported to the USGS in Denver. There, the samples were air-dried then ground to less than 150 micrometers. Chemical analyses

*Continued on page 8*

***If you have changes to the mailing list, please contact the Elbert County Environmental Health Officer (see page 12) or Tracy Yager (see page 12). Elbert County maintains the mailing list for these reports and for all meeting notices.***

***If you have questions about the Expanded Monitoring Program, please contact Tracy Yager (see page 12). Commonly asked questions will be included in each Progress Report.***

## ***Biosolids***

*Continued from page 7*

were completed and compiled for all biosolids samples collected from February through December 2004. Selected biosolids samples were analyzed for organic wastewater compounds (emerging contaminants).

### **Plans for the Current Period** **(July 2005–June 2006)**

The 2005 biosolids samples will be submitted for chemical analysis. Selected biosolids samples were leached with pure water in 2005; the leachates were analyzed for organic wastewater compounds (emerging contaminants).

## ***Soils***

### **Approach**

One site was selected for characterizing and monitoring the chemical composition of soil on the Metro District property in Arapahoe County, and one site was selected on the Metro District property in Elbert County. Each

site consists of three 20-acre (933 feet by 933 feet) fields separated by 100-foot buffer zones. The center 20-acre field at each site will have biosolids applied after the initial soil sampling. The other two 20-acre fields at each site will not have biosolids applied and will be used as “control” fields to monitor the natural variability of soil composition for the duration of the study. All three 20-acre fields at each site will be farmed in the normal fashion and have crops planted and harvested. Soils from each of the six fields will be sampled in 2010. Samples will be analyzed for arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc. Data will be examined to determine if concentrations have changed with time.

### **Progress Last Period** **(July 2004–June 2005)**

No soil samples were collected by the USGS during this period.

### **Plans for the Current Period** **(July 2005–June 2006)**

No soil samples will be collected by the USGS during this period, but the sampling fields should be maintained as described in the approach.

## ***Crops***

### **Approach**

Crops from each of the six 20-acre soil-monitoring fields will be chemically analyzed after harvest. Analyses will include arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc.

### **Progress Last Period** **(July 2004–June 2005)**

Wheat was harvested from the Arapahoe County fields in July 2004. The wheat samples were processed and analyzed.

### **Plans for the Current Period** **(July 2005–June 2006)**

None, unless crops are harvested from the sampling fields.



*The USGS met with small groups of stakeholders during November and December 2004 at various locations to discuss findings from the previous phase (1999–2003) of the USGS Expanded Monitoring Program near Deer Trail and priorities for the new phase (2005–2011) of the monitoring program near Deer Trail.*



## USGS ground-water data, July 2004–June 2005

[Data are preliminary and subject to revision. Standards from Colorado Department of Public Health and Environment, 1997, Basic standards for ground water, 5CCR 1002-41: July 14, 1997, 56 p. All data from filtered samples; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; E, value estimated by laboratory]

Well	Sample date	Nitrate plus nitrite as nitrogen, mg/L	Arsenic, µg/L	Cadmium, µg/L	Chromium, µg/L	Copper, µg/L	Lead, µg/L	Mercury, µg/L	Molybdenum, µg/L	Nickel, µg/L	Selenium, µg/L	Zinc, µg/L
DTX1	06/02/2005	1.35	2.8	0.10	0.8	6.3	<0.16	<0.01	6.2	36.2	15.9	3.9
DTX2	10/21/2004	<.04	1.1	E.04	<.8	11.8	<.16	<.01	1.6	6.44	1.5	9.2
DTX2	02/25/2005	<.04	1.3	E.04	<.8	7.2	<.16	<.01	1.7	11.1	2.2	6.5
DTX2	06/02/2005	<.04	1.8	<0.24	<8.0	6.8	<.48	<.01	1.7	31.4	4.5	5.2
DTX5	07/06/2004	1.26	.2	E.04	<.8	8.4	<.08	<.02	1.1	6.84	.7	4.1
DTX5	10/21/2004	1.59	.3	.05	<.8	6.6	<.08	<.01	1	3.55	.7	4.1
DTX6	07/08/2004	.25	E.3	<.08	<.8	13.2	<.16	<.02	E.8	4.19	3.4	6.4
DTX6	10/21/2004	.57	1.1	<.08	<.8	13.8	<.16	<.01	E.7	2.46	5.9	10.2
DTX8A	07/08/2004	<.04	.2	<.04	<.8	3.6	<.08	<.02	.6	1.36	<.4	2.4
DTX8A	10/19/2004	<.04	.3	<.04	<.8	2.8	<.08	<.01	.6	.8	.8	1.7
DTX10A	07/07/2004	<.04	E.3	<.08	<.8	12.7	<.16	<.02	1.3	7.1	.9	10.2
DTX10A	10/22/2004	<.04	.5	<.08	<.8	9.7	<.16	<.01	1.2	2.14	1.4	7.3
D6	07/07/2004	24.6	2.2	<.24	<1.6	29.8	<.48	<.02	3.4	14.9	41.9	29.2
D6	10/19/2004	25	10.3	.1	<1.6	33.9	<.08	<.01	3.9	16.4	67	20.3
D6	01/11/2005	27.2	10.5	<.28	<1.6	47.3	<.56	<.01	3.6	23.4	65.4	33.8
D6	06/01/2005	E31.5	9.6	<.56	<1.6	26.2	<1.12	<.01	27.1	147.29	20.7	16.1
D17	06/02/2005	.86	1.7	<.04	<.8	3.6	<.08	<.01	5.5	3.07	7.2	E.5
D25	10/19/2004	.12	2.4	.19	<.8	10.5	<.16	<.01	8.2	8.76	3.5	5.3
D25	02/25/2005	.13	1.8	.18	<.8	8	<.16	<.01	7.6	15.1	2.3	6.4
D25	06/01/2005	.52	2.8	.16	<8.0	10.2	<.16	<.01	1.1	11.45	20.5	8.4
D29	07/06/2004	<.04	E.2	<.08	.8	15.6	<.16	<.02	1.1	11.7	E.4	9.7
D29	10/20/2004	.05	.7	.08	<.8	14.7	<.16	<.01	.8	6.69	2	180
Human Health Standard		10	50	5	100	1,000	50	2	None	100	50	5,000
Agricultural Standard		100	100	10	100	200	100	10	None	200	20	2,000

### USGS biosolids data for samples collected February 2004 through December 2004

[Data are preliminary and subject to revision. Standards from Colorado Department of Public Health and Environment, 1993, Biosolids regulation, 5CCR 1002-64: April 14, 2003; ppm, parts per million; %, percent]

Sample date	Arsenic, ppm	Cadmium, ppm	Copper, ppm	Mercury, ppm	Molybdenum, ppm	Nickel, ppm	Lead, ppm	Selenium, ppm	Sulphur, %	Zinc, ppm
February 2004	2.1	2.2	542	1.5	20	22	44	7.5	1.27	565
March 2004	1.7	2.3	615	1.6	25	20	41	7.6	1.44	604
April 2004	1.7	2.2	641	1.8	31	20	46	8.9	1.48	659
May 2004	1.8	2.5	640	2.0	30	20	45	10	1.60	707
June 2004	1.9	2.1	648	1.4	35	19	47	9.7	1.60	728
July 2004	2.1	2.0	644	1.8	37	20	48	11	1.66	742
August 2004	2.3	2.3	668	1.4	31	26	56	10	1.53	747
September 2004	2.1	2.1	625	1.3	33	21	45	11	1.56	692
October 2004	1.9	2.0	642	1.9	34	22	46	10	1.56	708
November 2004	3.7	2.1	632	1.7	28	21	48	11	1.54	688
December 2004	1.7	2.0	565	1.6	25	20	49	9.3	1.49	666
Maximum Allowable for Grade I	41	39	1,500	17.0	75 (Grade II)	420	200	100	None	2,800

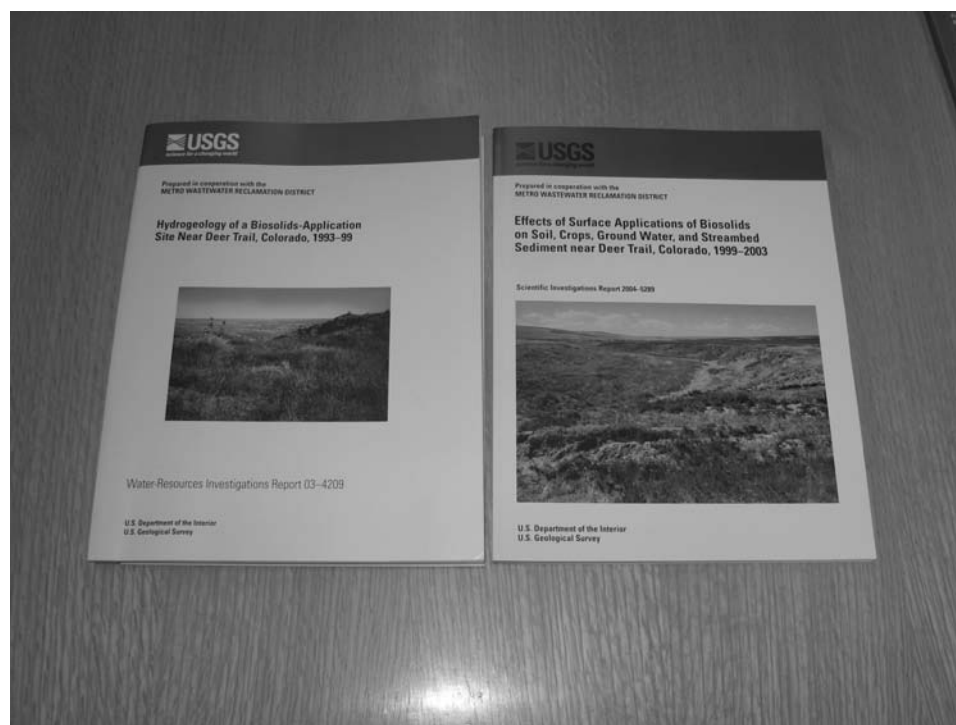
### USGS wheat-grain data for samples collected in 2004

[mg/kg, milligrams per kilogram; %, percent; <, less than]

Field sampled	Arsenic, mg/kg	Barium, mg/kg	Cadmium, mg/kg	Calcium, mg/kg	Chromium, mg/kg	Copper, mg/kg	Magnesium, mg/kg	Manganese, mg/kg	Mercury, mg/kg	Molybdenum, mg/kg	Selenium, mg/kg	Sodium, mg/kg	Total sulfur, %
Arapahoe County North Field (Control)	<0.1	8	0.04	475	0.5	5.3	1,520	36	<0.02	0.59	1.1	22	0.19
Arapahoe County Middle Field (Biosolids applied)	<.1	9.4	.08	402	.2	4.6	1,340	34	<.02	.62	.98	48	.16
Arapahoe County South Field (Control)	<.1	8.8	.03	400	.4	4.6	1,400	31	<.02	.75	.76	44	.16



***Four USGS data reports were completed for a previous phase (1999–2003) of the USGS Expanded Monitoring Program near Deer Trail. These reports are available to the public in paper copies and also available on the Internet.***



***Two USGS interpretive reports were completed for the previous phases of the USGS monitoring program near Deer Trail. These reports are available to the public in paper copies and also available on the Internet.***

## Definitions

*Biosolids*—Solid organic matter recovered from a sewage-treatment process that meets regulatory criteria for beneficial use, such as for fertilizer. Metro District applies Table 3 (Grade I), Class B biosolids near Deer Trail. Regulations require that land-applied biosolids must meet or exceed Table 1, Class B requirements. Table 3 Ceiling Concentration Limits are stricter than Table 1 Ceiling Concentration Limits.

*Composited sample*—A sample made by combining individual subsamples into a single sample. Each streambed-sediment sample from this program usually is a field-composited sample because the sample contains sediments from more than one depositional area of the streambed.

*Isotope*—One of two or more forms of a chemical element that have different atomic masses. The isotopic composition for some elements (such as nitrogen) can indicate sources of that element.

*Less than (<)*—A designation for analytical results to indicate that a constituent was not present or was present at very low levels that the laboratory could not reliably determine. Note that the actual amount of this constituent in that sample is unknown and could be any amount between zero and the “less than” value.

*Organic wastewater compounds*—Chemicals that are used every day in homes, industry, and agriculture that are found in very small concentrations in biosolids, in water released from wastewater treatment plants, or in other water impacted by humans. These chemicals include detergents, disinfectants, fragrances, fire retardants, pharmaceuticals, hormones, and pesticides. The source, fate, and effects of these chemicals on the environment are not well understood at this time.

*Runoff*—The rain that hits the ground and flows over the land surface into valleys instead of infiltrating into the soil. Runoff can wash particles of soil, rock, plants, and biosolids from the land surface into the streambeds of the valleys.

*Stakeholder*—Any person or group (including the Metro District) interested or concerned about the Expanded Monitoring Program.

## Contacts

USGS: Tracy Yager, 303–236–4882, ext. 225 (*email*: tjyager@usgs.gov)

Dave Smith, 303–236–1849

Jim Crock, 303–236–2452

Metro District: Nikki Stefonick, 303–286–3433

(*email*: NStefonick@mwr.dst.co.us)

Elbert County Environmental Health Officer: 303–621–3144

(*email*: elconurse@bewellnet.com)

State Biosolids Contact: Wes Carr, 303–692–3613

U.S. Environmental Protection Agency: Bob Brobst, 303–312–6129

***Seventh annual stakeholder  
meeting  
was September 28, 2005,  
at the Metro Wastewater  
Reclamation District property near  
Deer Trail, Colorado***

*Prepared by Tracy Yager, Dave Smith, and  
Jim Crock (USGS), in cooperation with  
Metro Wastewater Reclamation District,  
September 2005*

Tracy Yager  
U.S. Geological Survey  
Box 25046, MS415, DFC  
Denver, CO 80225–0046